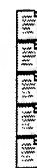


**JOURNAL BEARING MOUNTED HUB SEAL ROTARY JOINT****Publication number:** WO03004919**Publication date:** 2003-01-16**Inventor:** BEACH MATTHEW H (US); IVES ALAN T (US)**Applicant:** JOHNSON CORP (US); BEACH MATTHEW H (US);  
IVES ALAN T (US)**Classification:****- International:** *F16L27/08; F16L27/00*; (IPC1-7): F16L27/00**- European:** F16L27/08B2B**Application number:** WO2001US21144 20010702**Priority number(s):** WO2001US21144 20010702**Cited documents:**

US2460872

US2701146

US4928997

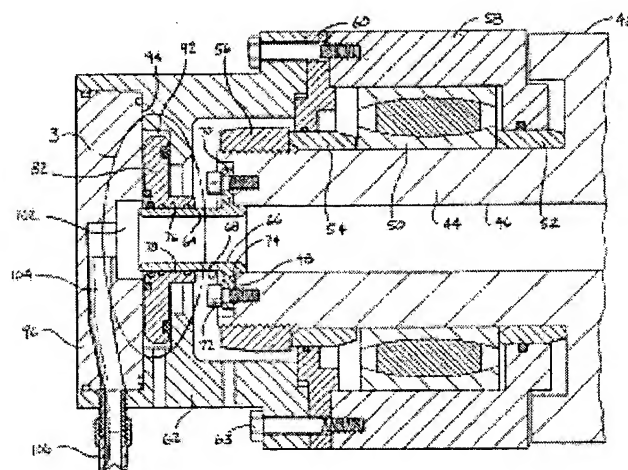
US5098135

US5110162

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A rotary joint for establishing communication between a rotating roll (10) and a heat transfer medium such as cooling water for controlling the roll temperature characterized by its rigid connection to the roll support structure (58) eliminating the necessity for the use of flexible supply or discharge conduits (40), permitting "hard" conduits and piping (106) to be used while the joint automatically compensates for roll radial and axial misalignment.

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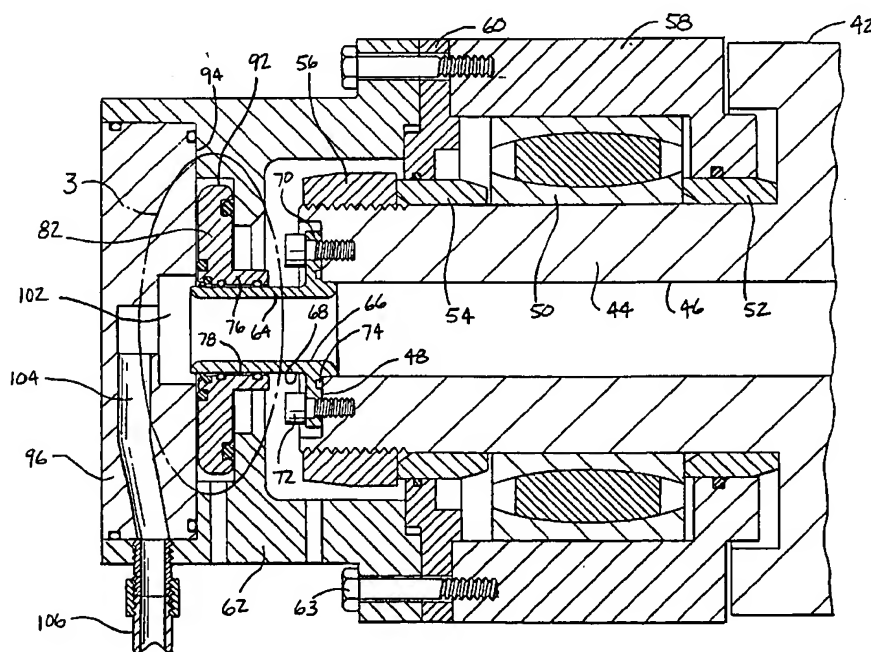
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(54) Title: **JOURNAL BEARING MOUNTED HUB SEAL ROTARY JOINT**



(57) Abstract: A rotary joint for establishing communication between a rotating roll (10) and a heat transfer medium such as cooling water for controlling the roll temperature characterized by its rigid connection to the roll support structure (58) eliminating the necessity for the use of flexible supply or discharge conduits (40), permitting "hard" conduits and piping (106) to be used while the joint automatically compensates for roll radial and axial misalignment.

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## JOURNAL BEARING MOUNTED HUB SEAL ROTARY JOINT

The invention pertains to rotary joints for supplying or removing a heat transfer medium relative to a rotating roll, or drum, and is of the self-aligning type to accommodate limited misalignment between stationary and rotating assembly components.

5 Rotary joints have long been used in manufacturing processes wherein rotating heated or cooled drums or rolls are used, for instance, in paper making, web drying, web printing, steel making, and the like, and the Assignee is a leader in the design and manufacture of rotary joints.

Rotating rolls and drums are supported upon coaxial journals that in turn  
10 are rotatably supported upon bearings that may be of the sleeve friction type, but are usually anti-friction ball or roller bearings, such as shown in Assignee's U.S. Patent Nos. 5,303,959 and 5,931,507. Because the roll or drum may be heated to relatively high temperatures due to exterior contact of the roll with a hot moving part, or because steam is injected into the roll to heat the roll for  
15 drying a web passing thereover, the resultant high temperatures within the drum will cause the drum dimensions to vary in accordance with the roll temperature and the rotary joint must incorporate features for compensating changes in the axial length of the roll or drum during operation. The aforementioned patents show various types of sealing structure used to compensate for such axial

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variations. Also, due to bearing wear, bearing housing misalignment and axial bending of the roll or drum, slight misalignment between the primary axis of the rotary joint and the axis of roll rotation may occur, and the rotary joint sealing structure needs to be designed to accommodate such misalignment, as shown  
5 in Assignee's U.S. Patent No. 4,606,561.

Rotary joints of the type illustrated in the above identified patents, and of conventional construction, utilize flexible conduits, such as synthetic or metal hose interposed between the hard supply conduits of the heat transfer medium and the rotary joint. Such flexible conduits are necessitated by the types of  
10 mounting used by rotary joints, and because of the need for the rotary joint to accommodate axial and rotative misalignment during roll and drum rotation. For many installations, the use of flexible metal hose attached to the rotary joint housing or cover structure is not satisfactory. These hoses are typically quite short, as dictated by the limited space available between the rotary joint and the  
15 machine framing. These short hoses therefore have limited flexibility and can exert large forces on the rotary joint, accelerating wear of the sealing components.

Further, in the continuous casting process of hot metal slabs wherein the hot slabs are supported by a series of metal rolls, the cooling of such rolls by  
20 water passing through the tubular rolls as supplied by a rotary joint in communication with the end of the roll has caused additional and more serious problems. Under conditions described above, the use of flexible metal hoses

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affixed to the rotary joints constitutes a "weak link" in the cooling of continuous casting slab supporting rolls.

As the hot metal slabs are moving upon the rolls, the slabs are very hot, having molten cores, the cast slab cores occasionally "breakout" causing molten steel to laterally flow with respect to the direction of metal slab movement, and this molten steel often damages the flexible metal hoses and conventional rotary joints. The metal hoses may become twisted, turned and forced out of operating position, and excessive external forces are applied to the rotary joint greatly reducing the rotary joint life. The rotary joints often fail in service during these molten steel breakouts and the continuous casting process must be terminated.

The resultant delays and repair of damage to the flexible metal hoses and rotary joints is very expensive, difficult, and time consuming, and prior to the advent of the instant invention, a solution to the above described problem has not been forthcoming.

It is an object of the invention to provide a rotary joint supplying a roll or drum with a fluid medium wherein the use of flexible metal or non-metal hoses is completely eliminated, and only "hard" conduits are used to supply the heat transfer medium.

Another object of the invention is to provide a rotary joint for rotating rolls or drums wherein the rotary joint housing or cover encases the end of the roll journal and hard piping or conduits, only, are used in conjunction with the rotary joint for resistance to damage, yet the rotary joint incorporates a seal structure

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that automatically accommodates axial dimensional changes in the roll and rotating misalignments relative to the axis of roll rotation.

Another object of the invention is to provide a rotary joint having sealing means between the joint and a rotating roll or drum wherein the sealing means  
5 accommodate roll axial dimensional changes and misalignment between the axes of the rotary joint and roll, and wherein rigid hard pipe connected to the rotary joint supplies the heat transfer medium through a rigid cover plate mounted upon the joint, with said rigid hard pipes not exerting any forces on the rotary joint that could increase seal wear.

10       Rolls or drums consist of a central cylindrical portion having cylindrical journals concentrically extending from each end. Each journal is supported upon bearings, usually of the anti-friction type, and the bearings are mounted within fixed housings to provide rigid support for the bearing outer race and the associated roll or drum. With continuous casting rolls, and with any roll or drum  
15 that is to be internally cooled or heated, a rotary joint supplies the fluid heat transfer medium, usually water or steam, into the open end of the journal which communicates with the bore of the cylindrical portion of the roll or drum. The journal end is in communication with the rotary joint and through sealing means, the rotary joint is sealed to the end of the journal.

20       Rather than using the usual flexible metal hose to supply the heat transfer medium to a "loosely" mounted rotary joint, the joint of the subject invention is rigidly fixed, preferably inside the bearing housing, and the rotary

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joint housing includes passages defined therein establishing communication between the journal end and the fluid heat transfer medium that is supplied by hard piping or conduits affixed to the rotary joint housing. The hard piping to the rotary joint is possible because of the rigid fixed characteristic of the rotary joint housing.

Sealing between the roll journal and the rotary joint structure is achieved by a cylindrical nipple that is concentrically mounted on the journal and axially extends beyond the journal end. The nipple may be bolted to the journal end, or may be located within a bushing mounted in the journal end concentric with the journal bore. In each instance, the nipple rotates with the journal and roll. A hub is mounted upon the exterior surface of the nipple for axial movement thereon and sealed thereto whereby relative rotation between the hub and sleeve may occur. The hub includes a radial flange having sealing means mounted upon the inside and outside surfaces which seal against radial surfaces formed on the rotary joint structure. A limited clearance exists between the hub bore and the nipple, and the hub flange and the rotary joint sealing surfaces, whereby the use of elastomeric O-ring type sealing rings permits effective sealing even though eccentricity of journal rotation may occur. The size and character of the O-rings is such as to accommodate such misalignment and eccentricity within the elastic limits of the O-rings.

Maintenance of rotary joint structure in accord with the invention is readily accomplished in that the rotary joint housing includes an access cover in

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alignment with the nipple and its hub. In the embodiment wherein the nipple is mounted within a journal mounted bushing, it is possible to remove the nipple and hub as a complete assembly for replacement or resealing purposes.

Because of the ability of the seal structure to accommodate misalignment  
5 between the rotary joint and roll journal, and because the relative axial movement between the nipple and the hub permits the accommodation of axial expansion of the roll, hard piping or conduits may be directly attached to the rotary joint housing, eliminating the necessity for flexible conduits such as flexible metal hose. By the use of such rigid piping, the likelihood of damage to  
10 the rotary joint in the event of hot metal slab core "breakout" is substantially reduced over conventional rotary joints using flexible metal hoses, and the rotary joint structure of the invention permits temperature control fluids to be employed with relatively small rolls in concise and easily serviceable configurations.

15 The objects and advantages of the invention will be appreciated from the following description and accompanying drawings wherein:

**FIG. 1** is an elevational diametrical sectional view of the prior art type of rotary joint previously utilized with continuous casting processing rolls for cooling purposes,

20 **FIG. 2** is an elevational diametrical sectional view of a rotary joint and roll in accord with the invention,

**FIG. 3** is an enlarged diametrical elevational sectional view of the



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sleeve and its hub as represented in FIG. 2, and

**FIG. 4** is an elevational diametrical sectional view of another embodiment of rotary joint in accordance with the inventive concepts wherein the nipple is mounted within a bushing located within the roll journal.

FIG. 1 discloses the type of rotary joint previously employed to cool the metal rolls supporting hot metal slabs in the continuous casting process for metal slabs. The roll upon which the metal slabs are supported is shown at 10, and the roll end journals are represented at 12, the bearing supporting the journal 12 is not illustrated. The body of the prior art rotary joint is shown at 14 and is inserted into a recess defined in the journal bore concentric with the axis of roll rotation. The body 14 is sealed with respect to the journal by O-ring seal 16 and includes flange 18 through which bolts 20 extend for reception into threaded holes 22 defined in the end of the journal 12.

A tubular nipple 24 is located within the rotary joint body 14 and is of an elongated cylindrical tubular construction having an inner radially extending shoulder 26 that prevents fluid pressure from pushing the nipple out of the body 14. The shoulder 26 rides on thrust bearing 25. A seal ring 28 seals the nipple with respect to the body.

The rotary joint head is represented at 30 and is received upon the end of the nipple 24 and affixed thereto by bolt 32 received within the nipple groove 34. A thrust bearing 36 is interposed between the joint body 14 and the inner

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end of the joint head 30. Snap ring 37 holds the thrust bearing 36 in position. Chamber 38 is defined within the joint head 30 in communication with the outer end of the nipple 24 and the metal flexible hose 40 is attached to the joint head 30 in communication with the chamber 38 to provide the cooling heat transfer medium, such as water, to the interior of the journal 12 and roll 10. A similar rotary joint construction may be utilized at the other end of the roll 10, not shown, for removing the water from the roll after the roll heat has been transferred thereto.

The joint head 30 is connected to a fixed support structure, not shown, by a torque rod, not shown, that passes through the joint head at torque rod hole 39. The flexible torque rod means are utilized in this respect to prevent the joint head from rotating, but permits limited axial and radial movement. Because of the use of the metal flexible hose 40, and the "loose" support of the joint head 30, the rotary joint structure is able to accommodate axial expansion of the roll 10 and misalignment of the axis of roll rotation. However, in the case of a metal slab core "breakout", the flowing molten metal will directly engage the joint head 30, its support structure and the flexible hose, and often damages the flexible metal hose 40 connected to the rotary joint. These breakouts may severely damage the rotary joint and require immediate repair, which is very time consuming and expensive as the metal slab processing must be terminated until the roll is replaced or repaired.

A rotary joint using concepts of the invention is shown in sectional

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assembled relationship in FIG. 2. The roll is represented at 42 having a cylindrical journal 44 at its end. A bore 46 extends through the journal and through the roll. The journal outer end is recessed at 48 for receiving nipple structure as later described, and a bearing 50 supports the journal 44. The 5 bearings 50 may be of the friction type, but are usually of the illustrated non-friction type employing spherical roller bearings. The bearing inner race is held in position by spacers 52 and 54 and the nut 56 threaded upon the end of the journal 44 squeezes the bearing inner race between the spacers to locate the bearing and journal. The bearing housing 58 is mounted upon a rigid support 10 structure, not shown, and a bearing seal plate 60 engages the housing 58. Lip seals or the like are used to seal the bearing housing 58 with respect to the spacers 52 and 54.

The bearing cover 62 is mounted upon the stationary bearing housing 58 by threaded bolts 63, and as the bolts 63 also pass through holes in the bearing 15 seal plate 60, these bolts will serve to position and fix the bearing seal plate and bearing cover relative to the bearing housing 58.

A nipple 64 is attached to the outer end of the journal 44 within the recess 48. The nipple 64 includes a central bore 66 communicating with the journal bore 46 and the nipple includes an outer cylindrical surface 68 and a radial 20 flange 70 having holes defined therein for receiving the threaded bolts 72 for attaching the nipple within the recessed end 48 of the journal 44. An O-ring 74 seals the flange 70 with respect to the journal end.

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Sealing with respect to the nipple 64 is achieved by the body 76 which is mounted upon the nipple outer surface 68 as will be appreciated from FIG. 3.

The body 76 includes bore 78 which is several thousandths of an inch larger than the diameter of the nipple surface 68, and axially spaced quad seals 80 seal the body bore 78 with respect to the nipple outer cylindrical surface 68. A radial flange 82 is defined upon the body 76 and includes a small ID O-ring 84 received within a groove formed in the flange outer face surface 86. The flange inner face surface 88 includes a groove radially located outwardly with respect to the O-ring 84 and receives the larger ID O-ring 90.

10 The body flange 82 is received within a recess 92 defined in the bearing cover 62. A further bearing cover recess 94 receives the rotary joint head 96. The bearing cover recess 92 defines the radial surface 97, while the head 96 defines the head surface 100 axially spaced with respect to bearing cover recess surface 97. The axial distance between body flange surfaces 86 and 88 is slightly less than the axial dimension separating surfaces 97 and 100, as will be appreciated in FIG. 3, and whose purpose is explained below.

A chamber 102 is defined in the head 96, the head being held in position by bolts, not shown, extending therethrough received within threaded holes, not shown, in the bearing cover 62, and passages 104 are defined in the head 96 in communication with the chamber 102 whereby hard piping 106 may be affixed to the bearing cover 62 eliminating the need for flexible metal hose.

The hard piping 106 can be directly connected to the bearing cover 62

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because the nipple 64 and body 76 will maintain a sealed relationship between the journal 44 and bearing cover 62 even though the length of the roll 42 increases and decreases with the temperature of the roll, and the sealed relationship with the rotary joint will be maintained if misalignment occurs  
5 between the axis of roll rotation and the general axis of the bearing cover 62.

Axial movement of the journal 44 relative to the bearing cover 62 is accommodated by the nipple 64 sliding within the body bore 78 and the quad seals 80 will maintain this sealed relationship even though relative axial displacement takes place between the nipple and body. It will be noted that the  
10 head chamber 102 is configured to accommodate such nipple displacement.

In the event of misalignment of the axes of the journal 44 and bearing cover 62, the larger size of the body bore 78 with respect to the diameter of the nipple outer surface 68 will permit a slight "tilting" of the nipple inside the body. Further tilting or misalignment will cause the body flange 82 to tilt with respect  
15 to the radial spacing defined by the body flange outer face surface 86 and the flange inner surface 88 relative to the bearing cover recess surface 97 and the head surface 100, respectively. This "tilting" of the body within the bearing cover recess 92 does not break the seal between the body flange and the head surface 100 because the seals 84 and 90 maintain engagement with the head  
20 surface 100 and bearing cover recess surface 97 due to the elastic characteristic of the O-rings 84 and 90.

The aforescribed relationship between the nipple, body and bearing

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cover produces a "floating" elastically mounted body which is force-balanced. The O-rings 84 and 90 are of such dimension, and are mounted in such dimensional grooves within the body flange 82 that the body is free to deflect 1° in any axial plane. To accomplish this sealing, the O-rings are formed from a soft durometer material with large cross sections. Different combinations of O-ring inside diameter and durometer can be selected to accomplish this objective.

In the event of a molten metal blowout, the rigid mounting of the bearing cover 62 upon the bearing housing 58 will protect the end of the journal 44 from damage, and permit the rotary joint body to resist damage. Further, by the use of hard piping or conduits 106, the likelihood of the molten steel damaging the piping or conduit system is significantly reduced. For further protection, the passages can be cast into the framework with said passages in direct fluid communication with the head passages 104. Servicing of the assembly shown in FIG. 2 is readily accomplished by removing the bolts, not shown, attaching the head 96 to the bearing cover 62 so that the head 96 may be removed permitting the body 76 to be pulled from the nipple 64. The opening 105 defined in the bearing cover 62 is sufficient to provide access to the bolts 72 permitting the nipple to be removed from the journal end. Thereupon, a new nipple and body can be installed.

The ability of the quad seals 80 and O-rings 84 and 90 to maintain a sealed relationship between the body 76 and the nipple 64 and the bearing cover 62 even if a slight misalignment between the roll axis of rotation and the

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axis of the bearing cover exists is due to the resilient characteristic of these seals to maintain engagement with their appropriate surfaces as shown in FIG. 3. During use, O-rings are slightly compressed. Accordingly, if tilting occurs between the nipple 64 and body 76, the resilient quad seals 80 will maintain a sealed relationship to the nipple outer surface 68 as long as such tilting is within the dimensional abilities of the quad seals 80, as exaggerated in FIG. 3. Likewise, FIG. 3 shows the body flange 82 tilted with respect to the bearing cover recess 92 whereby different circumferential portions of the O-rings 84 and 90 will be compressed variable degrees, but always within the elastomeric capabilities of the O-rings to engage their associated grooves and surfaces 97 and 100. Accordingly, the disclosed nipple and body arrangement permits automatic compensation for rotative misalignment. In order to prevent contaminants in the fluid from interfering with the sealing action of quad seals 80, a lip seal 107 is provided in the body 76, sealing against the nipple outer surface 68.

FIG. 4 illustrates a variation to the aforescribed structure wherein components similar to those previously described are indicated by primed reference numerals. The purpose of this variation is to permit the nipple and body to be removed as a unit for servicing purposes.

With reference to FIG. 4, journal 44' is supported by bearing 50' and spacer 52' and nut 56' hold the bearing in position. The bearing cover 62' attaches to the bearing housing 58' by bolts 63'. Seals 108 are interposed

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between the bearing housing 58' and the inner spacer 52' and the bearing cover 62' and nut 56', and it will be appreciated that the seals 108 are not of the O-ring configuration type.

A bushing 110 is slightly press fitted within the journal bushing bore 112 defined in the end of the roll journal 44'. The bushing bore 112 is of such a diameter as to closely receive the tubular bushing 110 having O-ring seals defined thereon for establishing a sealing relationship with the bushing 110. The nipple 114 includes a flanged outer end 118 and the inner end of the nipple includes a notch 119 receiving a key 121 affixed on the bushing 110 to cause rotation of the nipple 114 with the journal 44' and bushing 110. O-ring seals 116 seal the bushing 110 and nipple 114. A body 120 is rotationally movably supported upon the outer region of the nipple 114 and includes the appropriate O-rings 84' and 90' for cooperation with the bearing cover 62' and head 96' radial surfaces in the manner previously described. A thrust bearing 122 is imposed between the nipple flanged end 118 and body 120 and a snap ring 126 in a groove axially positions body 120 on nipple 114 and acts as a thrust bearing and insures that body 120 will be removed when nipple 114 is removed for servicing.

In the embodiment shown in FIG. 4, the sealing structure will accommodate both axial expansion of the roll and misalignment during rotation. The axial expansion is accommodated by the nipple 114 sliding axially inside the bushing 110. The misalignment is accommodated in the same manner as



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that described in FIGS. 2 and 3, with some additional misalignment capacity provided by the clearance between the nipple 114 and the bushing 110. The primary advantage of the embodiment of FIG. 4 lies in the fact that, for servicing or replacement purposes, the nipple 114 and body 120 can be removed as a unit once the head 96' is removed from the bearing cover 62'.

In the disclosed embodiment, only a single fluid path through the journal bore 46 is illustrated. However, it is to be appreciated that both embodiments of the invention may be designed by those skilled in the art wherein two conduit passages may extend through the roll. For instance, one of the passages may inject cool water into the roll, while the other passage removes the roll water that has been heated, and thereby insure cooling water circulation. This type of dual flow through a roll or drum is commonly used with heated drums wherein steam is injected through one port in the rotary joint, and the condensate is removed from another rotary joint port, as shown in the assignee's Patent No. 5,303,959.

Such modification to the disclosed embodiments is considered within the scope of this invention.

It will be appreciated that the described invention meets the intended results providing a low maintenance rotary joint capable of operating for long periods of time under the harsh conditions of a continuous casting hot metal slab mill. The elimination of flexible metal hosing eliminates a "weak link" in conventional rotary joint systems, and the unique sealing provided by the nipple and associated body accommodates slight misalignment without seal failure.

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Various modifications to the inventive concepts may be apparent to those skilled in the art without departing from the spirit and scope of the invention.

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## CLAIMS

1. A rotary joint for connecting a conduit system (106) to the end of the hollow journal (44) of a tubular roll (42) rotating about an axis of rotation characterized by its ability to accommodate and automatically compensate for roll radial and axial misalignment and eliminate the need for flexible supply or exhaust conduits comprising, in combination, a tubular nipple (64, 114) having an outer end and a cylindrical outer surface (68), means (70, 110) for mounting said nipple to the end of the roll journal in a substantially coaxial relationship thereto, a fixed bearing cover (62) rigidly mounted adjacent the journal end enclosing said nipple (64, 114), a self-aligning seal (76) mounted on said nipple interposed between said nipple and said bearing cover sealing said nipple with respect to said bearing cover during rotation of the journal, a passage (104) defined in said bearing cover in communication with said nipple outer end and a rigid conduit (106) affixed to said bearing cover in communication with said passage for supplying and/or removing heat transfer medium to the roll.

2. In a rotary joint as in claim 1, bearings (50) rotatably supporting the roll journal (44), a fixed bearing housing (58) supporting said bearings, said bearing cover (62) being mounted upon said bearing housing.

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3. In a rotary joint as in claim 1, said self aligning seal (76) comprising a rigid body (76) having a bore (78) mounted on said nipple outer surface (68) and a flange (82) received within a chamber (92) defined within said bearing cover having radially spaced recesses defined in inner (88) and outer (86) radial surfaces, and resilient annular seals (90, 84) within said recesses interposed between said bore and said nipple and said flange and said chamber.

4. In a rotary joint as in claim 1, said annular radial recesses defined in said body inner (88) and outer (86) surfaces being at different radial distances from the roll axis of rotation as determined by the size and resilient characteristics of the seals (90, 84) received therein.

5. In a rotary joint as in claim 1, said nipple (64) having a radial flange (70), and fasteners (72) extending through said flange affixing said nipple to the end of the roll hollow journal (44).

6. In a rotary joint as in claim 1, an annular bushing (110) concentrically fixed within the roll journal adjacent the journal end, said nipple (114) being received within bushing and sealed with respect thereto.

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7. A rotary joint for connecting a conduit system (106) to the end of the hollow journal of a tubular roll (42) rotating about an axis of rotation characterized by its ability to accommodate and automatically compensate for roll radial and axial misalignment and angular misalignment and eliminate the need for flexible supply or exhaust conduits comprising, in combination, a tubular nipple (64, 114) having an outer end and a cylindrical outer surface (68), means (70, 110) for mounting said nipple to the end of the roll journal in a substantially coaxial relationship thereto, an annular body (76) having a central bore (78) slightly greater than the diameter of said nipple for receiving said nipple, a radial flange (82) defined on said body having parallel axially spaced inner (88) and outer (86) radial surfaces defined thereon, first annular resilient seal means (80) interposed between said nipple outer surface and said body central bore, a fixed bearing cover (62) rigidly mounted adjacent the end of the roll journal, a chamber (92) defined in said bearing cover having spaced first (97) and second (100) walls radially disposed with respect to the journal axis of rotation, said radial body flange being located between said chamber walls and having an axial dimension slightly less than the axial spacing between said chamber walls, second (84) and third (90) annular resilient seal means interposed between said body flange surfaces and said chamber walls, said second annular resilient seal means interposed between said chamber second wall and said body outer surface and said third annular resilient seal means interposed between said chamber first wall (97) and said body inner surface

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whereby sealing is maintained between said body flange and said chamber walls even though limited angular misalignment exists between said head and body, and a passage (104) within said bearing cover in communication with said nipple outer end for establishing access through said bearing cover to the roll through said nipple.

8. In a rotary joint as in claim 7, said first seal means (80) comprising resilient rings.

9. In a rotary joint as in claim 8, annular recesses defined in said body central bore, said first seal means (80) being received within said recesses.

10. In a rotary joint as in claim 7, said second (84) and third (90) seal means comprising resilient rings.

11. In a rotary joint as in claim 10, annular recesses defined in said body radial surfaces, said second (84) and third (90) annular seal means being received within said body recesses.

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12. In a rotary joint as in claim 11, said annular radial recesses defined in said body inner and outer surfaces being at different radial distances from the roller axis of rotation as determined by the size and resilient characteristics of said second (84) and third (90) seal means and the tolerances between said body flange (82) and said chamber walls (97, 100).

13. In a rotary joint as in claim 7, said nipple having a radial flange(70), and fasteners (72) extending through said flange affixing said nipple to the end of the roll hollow journal.

14. In a rotary joint as in claim 7, an annular bushing (110) concentrically fixed within the roll journal adjacent the journal end, said nipple (114) being received within bushing and sealed with respect thereto allowing axial movement to accommodate thermal expansion of said roll.

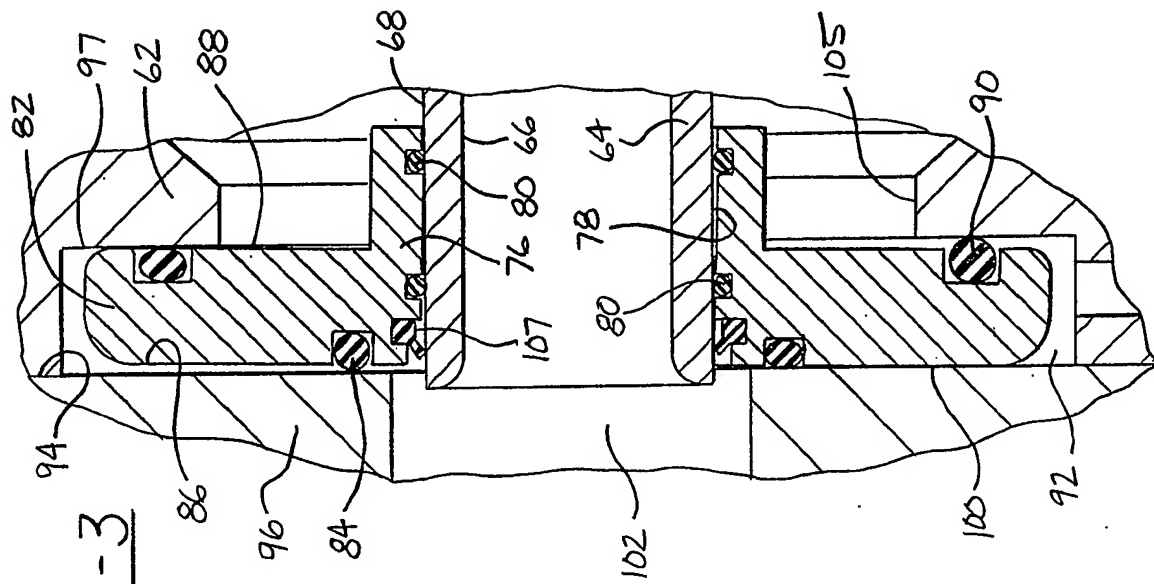


FIG-3

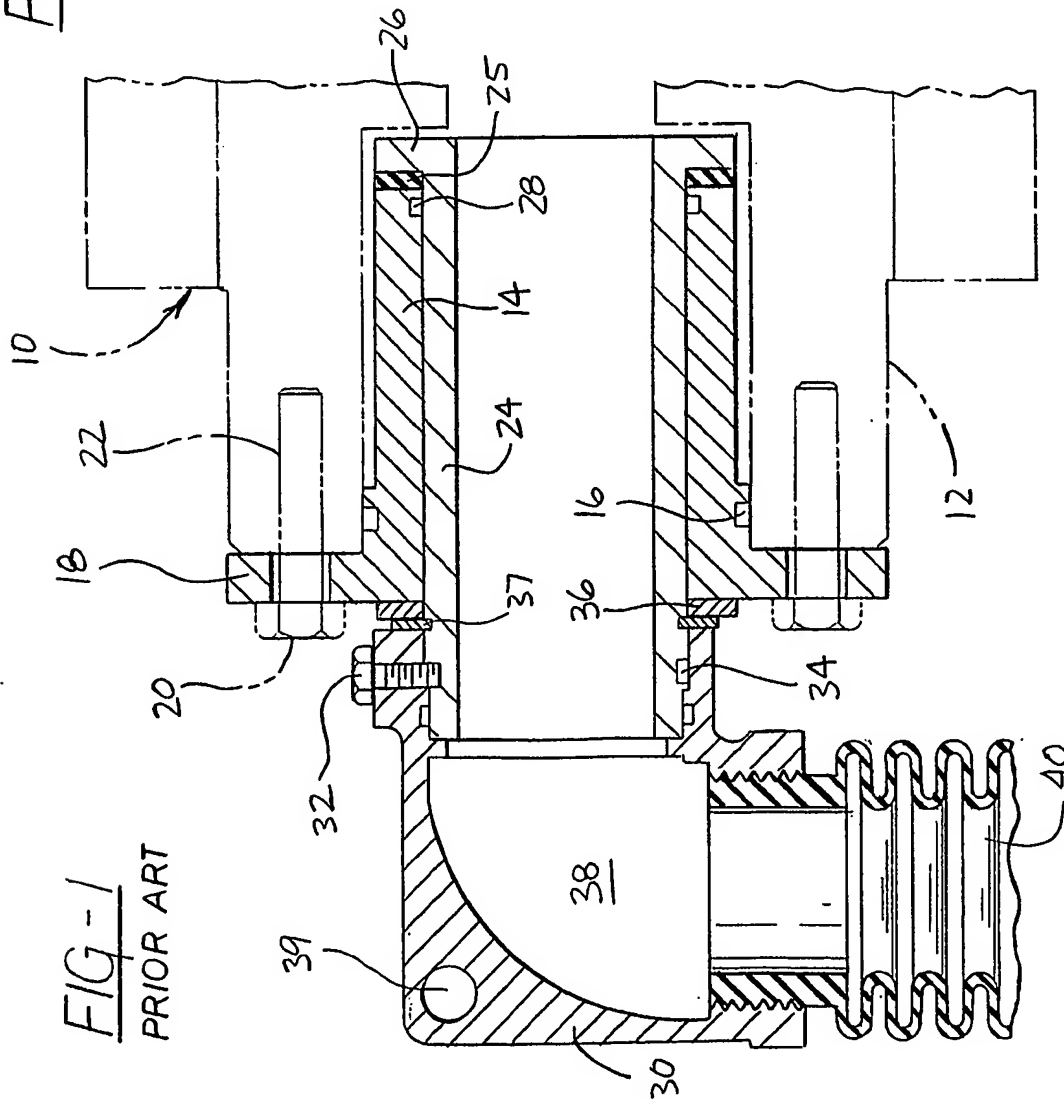


FIG-1  
PRIOR ART



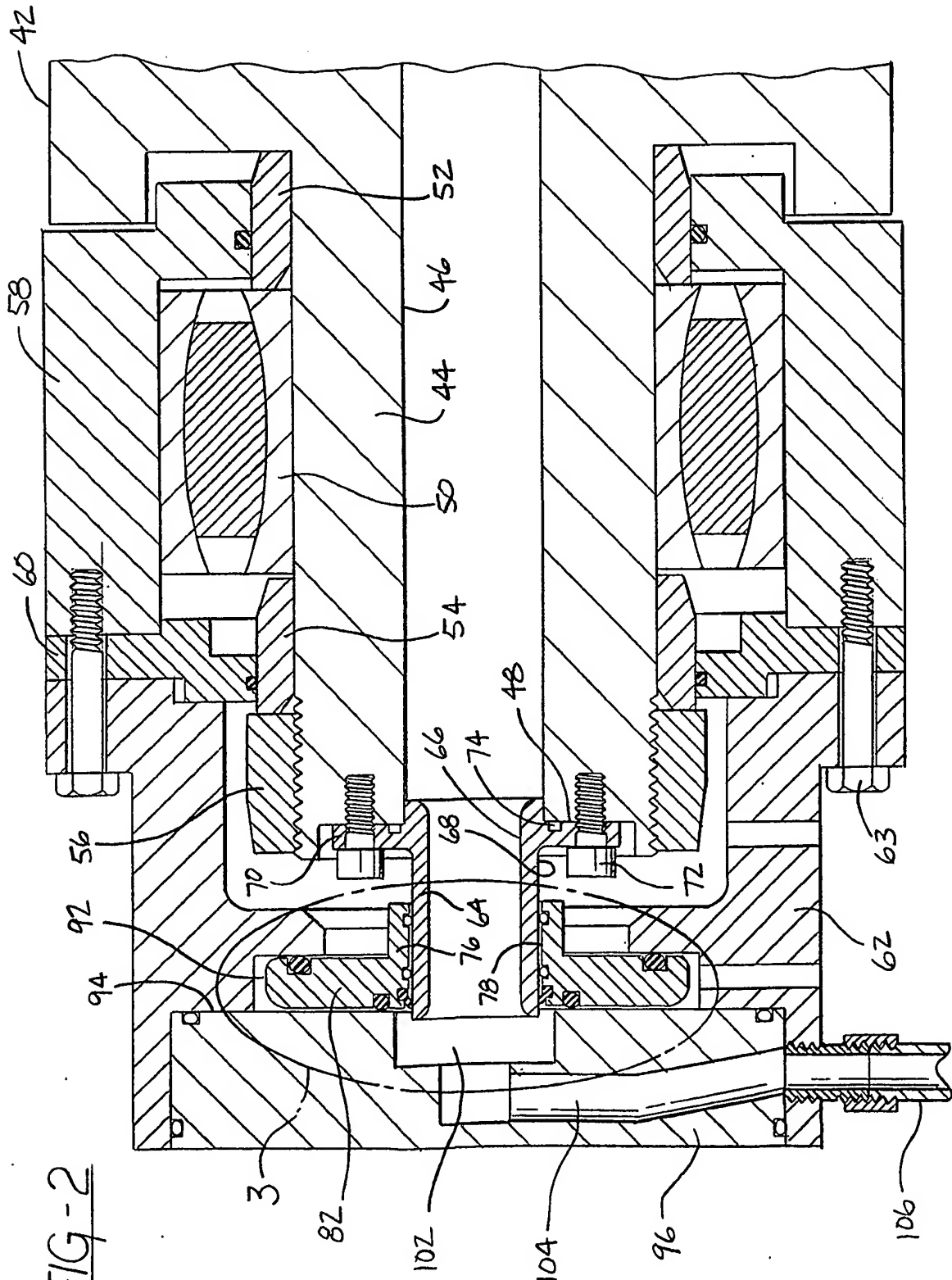


FIG-2

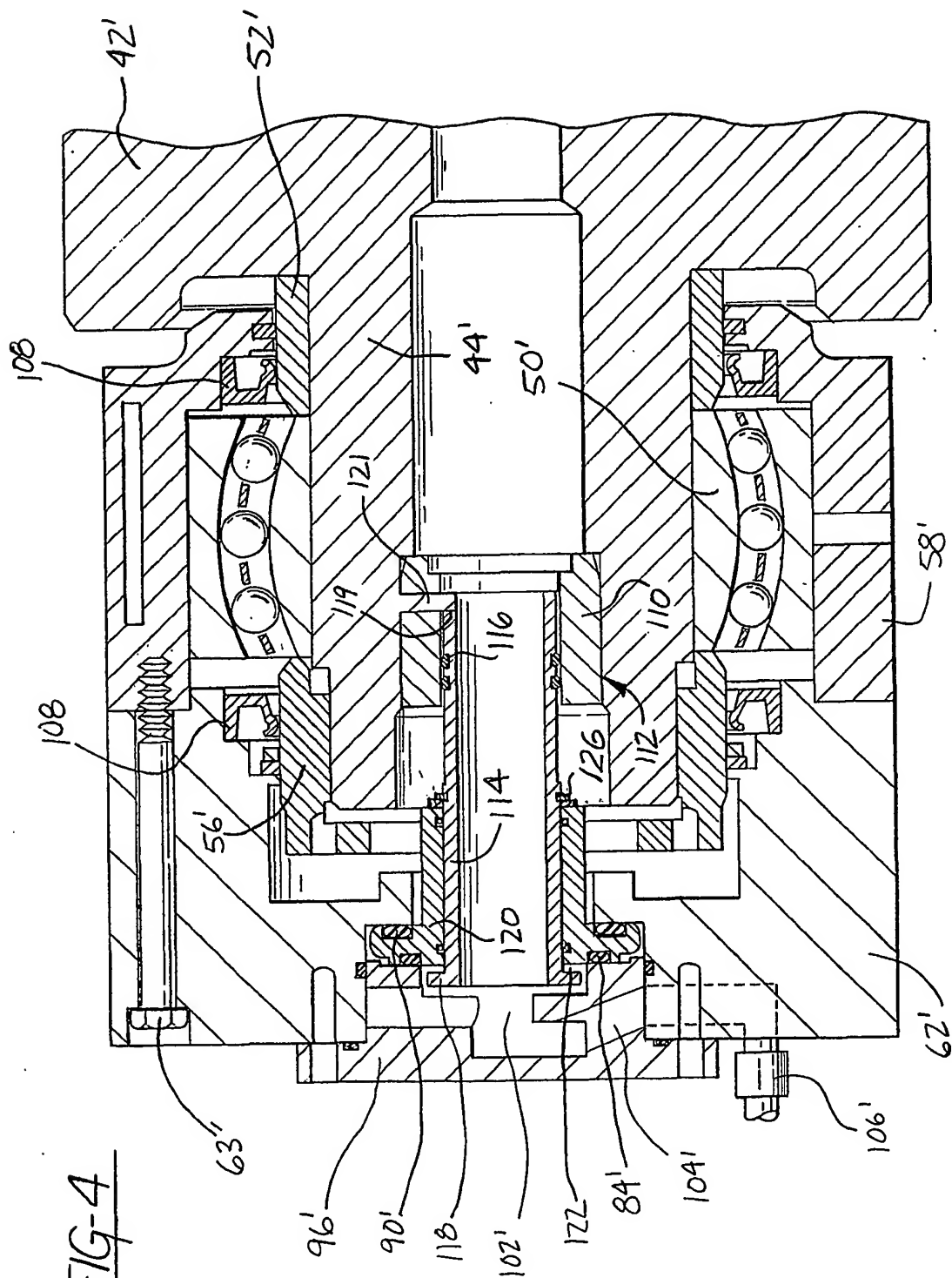


FIG-4

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/21144

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : F16L 27/00  
US CL : 285/281, 272

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 285/121.6, 121.3, 121.5, 278, 281, 272

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2,460,872 A (CARPENTER) 08 February 1949 (08.02.1949)	1, 7
A	US 2,701,146 A (WARREN) 01 February 1955 (01.02.1955)	1, 7
A	US 4,928,997 A (REISENER et al) 29 May 1990 (29.05.1990)	1, 7
A	US 5,098,135 A (TIMM) 24 March 1992 (24.03.1992)	1, 7
A	US 5,110,162 A (PETER et al) 05 May 1992 (05.05.1992)	1, 7
A	US 5,209,526 A (BECCIA et al) 11 May 1993 (11.05.1993)	1, 7
A	US 2,911,234 A (HIERONYMUS) 03 November 1959 (03.11.1959)	1, 7
A	US 3,017,202 A (SWANEY) 16 January 1962 (16.01.1962)	1, 7
A	US 3,484,453 A (NISHI) 16 December 1969 (16.12.1969)	1, 7



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

03 December 2001 (03.12.2001)

Name and mailing address of the ISA/US

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# INTERNATIONAL SEARCH REPORT

International application No.

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## C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3,606,394 A (MAURER et al) 20 September 1971 (20.09.1971)	1, 7
A	US 2,045,634 A (CRAM) 30 June 1936 (30.06.1936)	1; 7